Asingment 3 - Javier Fernandez

Information

Assignment #3

Class: Econ 613

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Date: April 26th, 2021

Preliminaries ——

```
rm(list=ls())

# Libraries
library(data.table)
library(moments)
library(stargazer)
library(tidyverse)

# Set WD
setwd("C:/Users/javie/OneDrive/Documents/GitHub/ECON613/Assingments/A3")
```

I - Loading Datasets

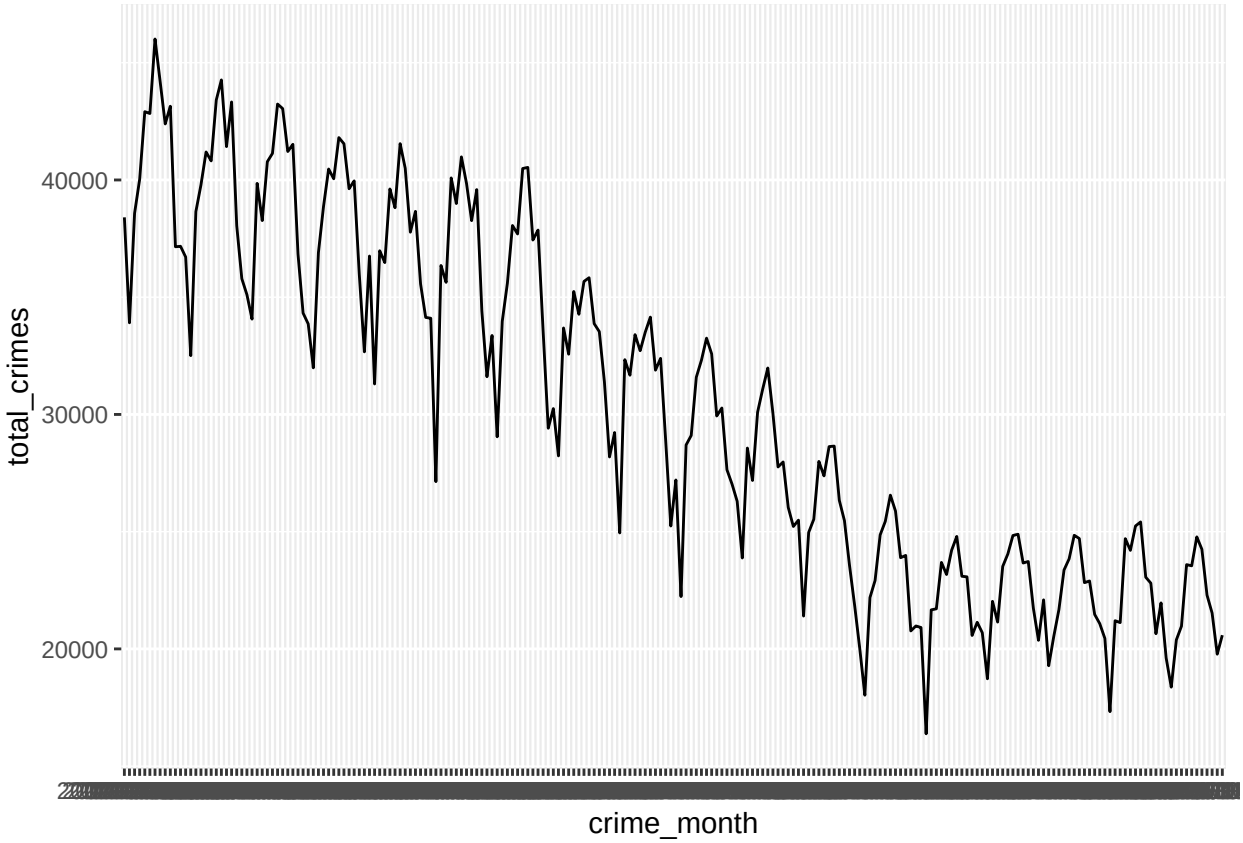
```
#Load data
population <- read.csv("population.csv")
crime <- read.csv("crime_long.csv")
```

II - Data Manipulation

2.1 Calculate total crime per month and plot the time series of crime.

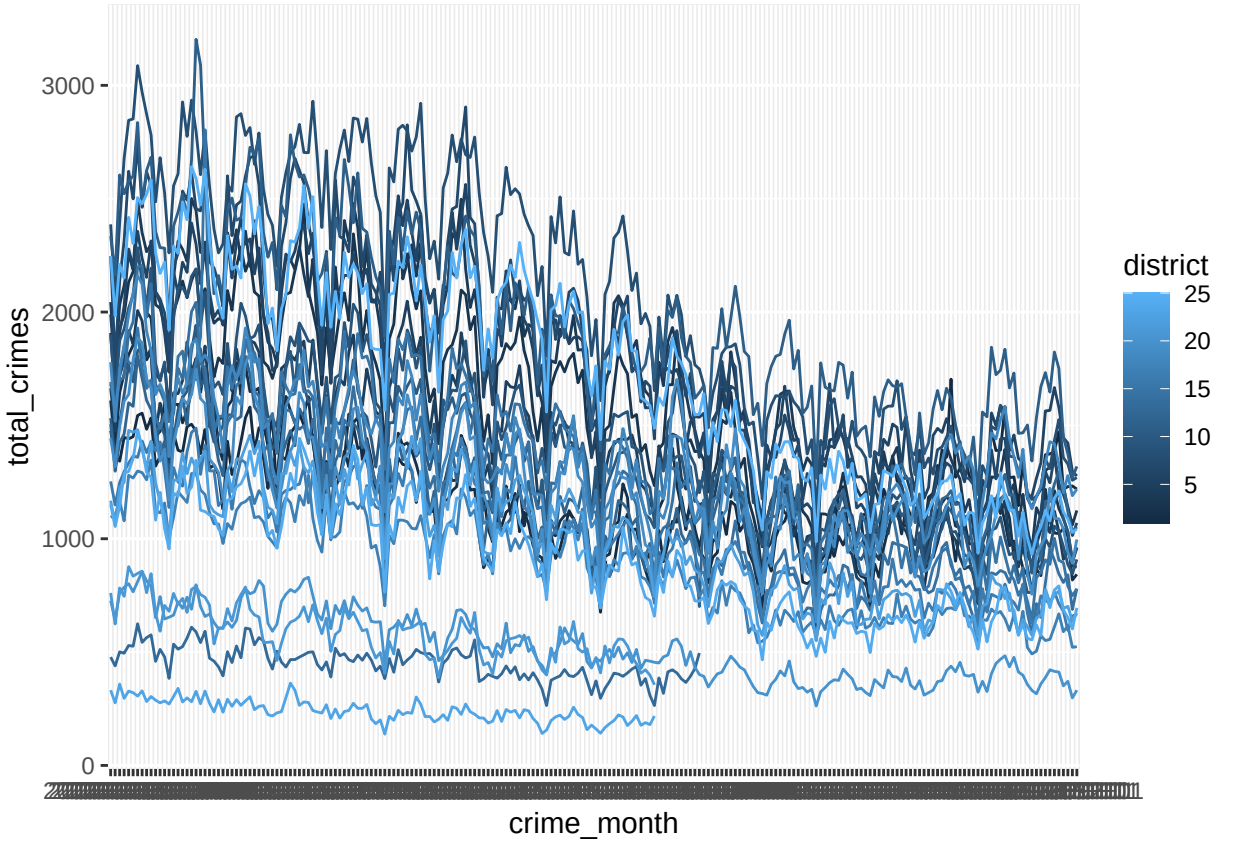
- a. Total crime overall

```
total_a <- crime %>% group_by(crime_month) %>% summarize(total_crimes=sum(crimes))
ggplot(data = total_a,aes(x=crime_month,y=total_crimes,group=1))+geom_line()
```



- b. Total crime by district

```
total_b <- crime %>% group_by(crime_month,district) %>% summarize(total_crimes=sum(crimes))
ggplot(data=total_b,aes(x=crime_month,y=total_crimes,
                        colour=district,group=district)) +
  geom_line()
```




```
# Mege crime by district
crime <- left_join(crime,total_b)
```

2.2 Merge the two datasets by districts-units and period.

```
crime  <- crime %>% pivot_wider(names_from=crime_type,values_from=crimes,
values_fn=sum) # As there are some rows with the same months and district and different values,
               # we use values_fn
population <- population %>% rename(crime_month=month)
pop_crime <- left_join(crime,population)
```

3. Construct a panel data of unit over time with the following variables

* Total crimes per resident
* Violent crimes per resident
* Property crimes per resident
* Median income
* Share of black, hispanic and white residents

```
# Creating variables
Variables <-pop_crime %>% group_by(crime_month,district) %>%
  summarise(tot_crim_per_res=total_crimes/tot_pop,
```

```
            viol_crim_per_res=violent/tot_pop,
            prop_crim_per_res=property/tot_pop,
            share_black=tot_black/tot_pop,
            share_hisp=tot_hisp/tot_pop,
            share_white=tot_white/tot_pop)

# Creating panel data
panel_crime <- left_join(pop_crime,Variables)
```

III - Panel Data: Introduction

```
#Load data
officers <- read.csv("officers.csv")

officers <- officers %>% rename(district=unit,crime_month=month)

final_panel <- left_join(officers,panel_crime)


model1 <- lm(data=final_panel,
             arrest~tenure+tot_crim_per_res+p50_inc+share_white+share_hisp+share_black)

summary(model1)
```

```
##
## Call:
## lm(formula = arrest ~ tenure + tot_crim_per_res + p50_inc + share_white +
##     share_hisp + share_black, data = final_panel)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5017 -0.4993 -0.4982  0.5009  5.5026
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)       5.068e-01  1.273e-02  39.809   <2e-16 ***
## tenure           -4.394e-06  8.338e-06  -0.527    0.598
## tot_crim_per_res -2.334e-02  1.266e-01  -0.184    0.854
## p50_inc           2.613e-08  9.529e-08   0.274    0.784
## share_white      -1.275e-02  1.695e-02  -0.752    0.452
## share_hisp       -5.229e-03  1.325e-02  -0.395    0.693
## share_black      -7.643e-03  1.262e-02  -0.605    0.545
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7068 on 1077898 degrees of freedom
##   (31 observations deleted due to missingness)
## Multiple R-squared:  2.049e-06,  Adjusted R-squared:  -3.517e-06
## F-statistic: 0.3681 on 6 and 1077898 DF,  p-value: 0.8995
```

IV - Panel Data: More Controls

```
model2 <- lm(data=final_panel,
             arrest~tenure+tot_crim_per_res+p50_inc+share_white+share_hisp+share_black+
     factor(crime_month)+factor(district))

summary(model2)
```

```
##
## Call:
## lm(formula = arrest ~ tenure + tot_crim_per_res + p50_inc + share_white +
##     share_hisp + share_black + factor(crime_month) + factor(district),
##     data = final_panel)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5280 -0.5003 -0.4920  0.5008  5.5156
##
## Coefficients:
##                                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)                     6.447e-01  1.065e-01   6.056  1.4e-09 ***
## tenure                         -3.667e-06  8.526e-06  -0.430   0.6671
## tot_crim_per_res               -6.000e-01  3.939e-01  -1.523   0.1277
## p50_inc                        -4.522e-08  6.531e-07  -0.069   0.9448
## share_white                    -1.729e-01  1.846e-01  -0.936   0.3491
## share_hisp                     -1.434e-01  2.026e-01  -0.708   0.4792
## share_black                    -7.815e-02  1.044e-01  -0.749   0.4539
## factor(crime_month)2007-02-01  2.688e-03  1.108e-02   0.243   0.8083
## factor(crime_month)2007-03-01  5.459e-03  1.098e-02   0.497   0.6190
## factor(crime_month)2007-04-01 -4.482e-03  1.099e-02  -0.408   0.6835
## factor(crime_month)2007-05-01  9.708e-03  1.103e-02   0.881   0.3786
## factor(crime_month)2007-06-01 -1.514e-02  1.098e-02  -1.378   0.1681
## factor(crime_month)2007-07-01 -2.428e-03  1.103e-02  -0.220   0.8257
## factor(crime_month)2007-08-01 -9.282e-03  1.098e-02  -0.845   0.3981
## factor(crime_month)2007-09-01  2.826e-03  1.095e-02   0.258   0.7963
## factor(crime_month)2007-10-01  5.442e-03  1.095e-02   0.497   0.6193
## factor(crime_month)2007-11-01  3.148e-03  1.088e-02   0.289   0.7724
## factor(crime_month)2007-12-01 -8.606e-03  1.089e-02  -0.790   0.4293
## factor(crime_month)2008-01-01 -1.592e-02  1.090e-02  -1.461   0.1441
## factor(crime_month)2008-02-01 -8.111e-03  1.095e-02  -0.741   0.4588
## factor(crime_month)2008-03-01 -7.140e-03  1.090e-02  -0.655   0.5124
## factor(crime_month)2008-04-01  7.855e-03  1.089e-02   0.721   0.4708
## factor(crime_month)2008-05-01  1.881e-02  1.090e-02   1.726   0.0843 .
## factor(crime_month)2008-06-01  9.715e-04  1.087e-02   0.089   0.9288
## factor(crime_month)2008-07-01  4.697e-05  1.088e-02   0.004   0.9966
## factor(crime_month)2008-08-01  1.097e-03  1.090e-02   0.101   0.9198
## factor(crime_month)2008-09-01  9.332e-03  1.085e-02   0.860   0.3896
## factor(crime_month)2008-10-01 -3.433e-03  1.084e-02  -0.317   0.7515
## factor(crime_month)2008-11-01 -1.710e-03  1.083e-02  -0.158   0.8746
## factor(crime_month)2008-12-01  1.069e-02  1.087e-02   0.983   0.3257
## factor(crime_month)2009-01-01 -6.240e-03  1.085e-02  -0.575   0.5654
## factor(crime_month)2009-02-01 -6.053e-03  1.091e-02  -0.555   0.5790
```

```
## factor(crime_month)2009-03-01 -9.074e-03  1.085e-02  -0.836   0.4031
## factor(crime_month)2009-04-01 -5.101e-03  1.087e-02  -0.469   0.6390
## factor(crime_month)2009-05-01 -1.690e-03  1.086e-02  -0.156   0.8763
## factor(crime_month)2009-06-01  4.015e-03  1.086e-02   0.370   0.7116
## factor(crime_month)2009-07-01  5.287e-03  1.086e-02   0.487   0.6265
## factor(crime_month)2009-08-01 -4.865e-03  1.087e-02  -0.448   0.6544
## factor(crime_month)2009-09-01 -4.997e-03  1.088e-02  -0.460   0.6459
## factor(crime_month)2009-10-01 -1.736e-03  1.088e-02  -0.160   0.8732
## factor(crime_month)2009-11-01 -5.456e-03  1.089e-02  -0.501   0.6163
## factor(crime_month)2009-12-01 -1.016e-02  1.094e-02  -0.928   0.3533
## factor(crime_month)2010-01-01  1.589e-03  1.093e-02   0.145   0.8844
## factor(crime_month)2010-02-01  3.341e-03  1.112e-02   0.301   0.7638
## factor(crime_month)2010-03-01 -9.070e-03  1.099e-02  -0.825   0.4094
## factor(crime_month)2010-04-01  6.835e-03  1.101e-02   0.621   0.5346
## factor(crime_month)2010-05-01 -3.666e-03  1.101e-02  -0.333   0.7393
## factor(crime_month)2010-06-01 -6.040e-03  1.102e-02  -0.548   0.5837
## factor(crime_month)2010-07-01 -1.367e-02  1.102e-02  -1.240   0.2151
## factor(crime_month)2010-08-01  9.654e-03  1.103e-02   0.875   0.3816
## factor(crime_month)2010-09-01  2.027e-03  1.103e-02   0.184   0.8542
## factor(crime_month)2010-10-01 -2.743e-03  1.103e-02  -0.249   0.8035
## factor(crime_month)2010-11-01 -9.360e-03  1.109e-02  -0.844   0.3985
## factor(crime_month)2010-12-01 -5.077e-03  1.119e-02  -0.454   0.6500
## factor(crime_month)2011-01-01 -8.490e-03  1.117e-02  -0.760   0.4472
## factor(crime_month)2011-02-01 -5.744e-03  1.137e-02  -0.505   0.6135
## factor(crime_month)2011-03-01 -4.794e-03  1.120e-02  -0.428   0.6686
## factor(crime_month)2011-04-01 -1.478e-03  1.120e-02  -0.132   0.8950
## factor(crime_month)2011-05-01 -7.965e-04  1.117e-02  -0.071   0.9431
## factor(crime_month)2011-06-01 -5.277e-05  1.115e-02  -0.005   0.9962
## factor(crime_month)2011-07-01  3.844e-03  1.113e-02   0.345   0.7299
## factor(crime_month)2011-08-01 -2.397e-04  1.114e-02  -0.022   0.9828
## factor(crime_month)2011-09-01 -1.157e-02  1.100e-02  -1.052   0.2929
## factor(crime_month)2011-10-01  1.026e-02  1.099e-02   0.933   0.3506
## factor(crime_month)2011-11-01 -7.203e-03  1.104e-02  -0.653   0.5141
## factor(crime_month)2011-12-01  5.203e-05  1.106e-02   0.005   0.9962
## factor(crime_month)2012-01-01 -1.070e-02  1.110e-02  -0.964   0.3352
## factor(crime_month)2012-02-01  2.731e-03  1.115e-02   0.245   0.8065
## factor(crime_month)2012-03-01  1.799e-03  1.103e-02   0.163   0.8704
## factor(crime_month)2012-04-01  4.312e-03  1.111e-02   0.388   0.6981
## factor(crime_month)2012-05-01  4.070e-03  1.107e-02   0.368   0.7131
## factor(crime_month)2012-06-01 -2.417e-03  1.108e-02  -0.218   0.8273
## factor(crime_month)2012-07-01  2.953e-04  1.108e-02   0.027   0.9787
## factor(crime_month)2012-08-01 -5.476e-03  1.111e-02  -0.493   0.6221
## factor(crime_month)2012-09-01  2.019e-03  1.115e-02   0.181   0.8564
## factor(crime_month)2012-10-01 -1.480e-02  1.115e-02  -1.328   0.1843
## factor(crime_month)2012-11-01  3.212e-03  1.120e-02   0.287   0.7744
## factor(crime_month)2012-12-01 -1.712e-02  1.124e-02  -1.523   0.1278
## factor(crime_month)2013-01-01  3.537e-03  1.126e-02   0.314   0.7535
## factor(crime_month)2013-02-01 -8.270e-03  1.142e-02  -0.724   0.4690
## factor(crime_month)2013-03-01 -1.604e-02  1.130e-02  -1.419   0.1558
## factor(crime_month)2013-04-01  3.347e-03  1.127e-02   0.297   0.7664
## factor(crime_month)2013-05-01  1.396e-02  1.120e-02   1.247   0.2125
## factor(crime_month)2013-06-01  6.787e-03  1.123e-02   0.604   0.5455
## factor(crime_month)2013-07-01  1.735e-02  1.120e-02   1.550   0.1213
## factor(crime_month)2013-08-01 -2.991e-03  1.121e-02  -0.267   0.7896
```

```
## factor(crime_month)2013-09-01  2.827e-03  1.126e-02   0.251   0.8017
## factor(crime_month)2013-10-01 -8.852e-03  1.128e-02  -0.785   0.4327
## factor(crime_month)2013-11-01 -5.916e-03  1.134e-02  -0.522   0.6020
## factor(crime_month)2013-12-01  3.222e-03  1.141e-02   0.282   0.7776
## factor(crime_month)2014-01-01 -1.504e-02  1.152e-02  -1.305   0.1917
## factor(crime_month)2014-02-01  2.457e-03  1.160e-02   0.212   0.8323
## factor(crime_month)2014-03-01 -4.543e-03  1.142e-02  -0.398   0.6907
## factor(crime_month)2014-04-01 -1.875e-02  1.138e-02  -1.648   0.0993 .
## factor(crime_month)2014-05-01 -6.031e-03  1.130e-02  -0.534   0.5935
## factor(crime_month)2014-06-01 -1.927e-03  1.124e-02  -0.171   0.8639
## factor(crime_month)2014-07-01  5.428e-03  1.122e-02   0.484   0.6284
## factor(crime_month)2014-08-01 -1.231e-03  1.124e-02  -0.109   0.9128
## factor(crime_month)2014-09-01  9.240e-04  1.125e-02   0.082   0.9346
## factor(crime_month)2014-10-01 -1.863e-03  1.125e-02  -0.166   0.8684
## factor(crime_month)2014-11-01 -8.657e-03  1.137e-02  -0.761   0.4465
## factor(crime_month)2014-12-01 -7.107e-03  1.137e-02  -0.625   0.5319
## factor(crime_month)2015-01-01 -5.012e-03  1.140e-02  -0.439   0.6603
## factor(crime_month)2015-02-01 -9.371e-03  1.165e-02  -0.804   0.4212
## factor(crime_month)2015-03-01  4.080e-03  1.139e-02   0.358   0.7201
## factor(crime_month)2015-04-01 -3.546e-03  1.141e-02  -0.311   0.7559
## factor(crime_month)2015-05-01 -6.848e-03  1.133e-02  -0.605   0.5454
## factor(crime_month)2015-06-01 -7.264e-03  1.133e-02  -0.641   0.5216
## factor(crime_month)2015-07-01 -8.688e-03  1.129e-02  -0.769   0.4417
## factor(crime_month)2015-08-01 -5.383e-03  1.128e-02  -0.477   0.6332
## factor(crime_month)2015-09-01 -1.112e-03  1.136e-02  -0.098   0.9221
## factor(crime_month)2015-10-01 -8.459e-03  1.136e-02  -0.745   0.4564
## factor(crime_month)2015-11-01  2.233e-03  1.145e-02   0.195   0.8454
## factor(crime_month)2015-12-01 -7.467e-03  1.145e-02  -0.652   0.5143
## factor(crime_month)2016-01-01 -5.436e-03  1.149e-02  -0.473   0.6362
## factor(crime_month)2016-02-01 -7.145e-03  1.157e-02  -0.618   0.5369
## factor(crime_month)2016-03-01 -1.459e-02  1.141e-02  -1.278   0.2011
## factor(crime_month)2016-04-01  9.746e-03  1.144e-02   0.852   0.3943
## factor(crime_month)2016-05-01  9.780e-03  1.134e-02   0.862   0.3885
## factor(crime_month)2016-06-01 -5.268e-03  1.132e-02  -0.465   0.6417
## factor(crime_month)2016-07-01 -1.088e-02  1.130e-02  -0.963   0.3355
## factor(crime_month)2016-08-01 -1.938e-02  1.127e-02  -1.719   0.0857 .
## factor(crime_month)2016-09-01 -1.692e-03  1.131e-02  -0.150   0.8811
## factor(crime_month)2016-10-01  2.942e-03  1.132e-02   0.260   0.7950
## factor(crime_month)2016-11-01 -1.412e-02  1.141e-02  -1.237   0.2159
## factor(crime_month)2016-12-01 -1.301e-02  1.145e-02  -1.137   0.2556
## factor(crime_month)2017-01-01 -7.456e-05  1.147e-02  -0.007   0.9948
## factor(crime_month)2017-02-01 -5.915e-03  1.158e-02  -0.511   0.6095
## factor(crime_month)2017-03-01  6.010e-03  1.153e-02   0.521   0.6021
## factor(crime_month)2017-04-01 -5.728e-03  1.149e-02  -0.499   0.6180
## factor(crime_month)2017-05-01  8.370e-03  1.142e-02   0.733   0.4637
## factor(crime_month)2017-06-01 -1.221e-02  1.140e-02  -1.071   0.2841
## factor(crime_month)2017-07-01 -6.187e-03  1.138e-02  -0.544   0.5865
## factor(crime_month)2017-08-01 -2.645e-03  1.139e-02  -0.232   0.8164
## factor(crime_month)2017-09-01 -8.596e-03  1.145e-02  -0.751   0.4528
## factor(crime_month)2017-10-01 -9.805e-03  1.143e-02  -0.858   0.3910
## factor(crime_month)2017-11-01 -1.685e-02  1.150e-02  -1.466   0.1426
## factor(crime_month)2017-12-01 -8.978e-03  1.149e-02  -0.781   0.4347
## factor(district)2             -4.795e-02  2.439e-02  -1.966   0.0493 *
## factor(district)3             -4.873e-02  2.722e-02  -1.791   0.0734 .
```

```
## factor(district)4            -3.018e-02  3.375e-02  -0.894   0.3711
## factor(district)5            -4.892e-02  2.845e-02  -1.719   0.0855 .
## factor(district)6            -5.033e-02  2.974e-02  -1.692   0.0906 .
## factor(district)7            -4.987e-02  2.761e-02  -1.806   0.0709 .
## factor(district)8            -3.717e-04  6.479e-02  -0.006   0.9954
## factor(district)9            -1.359e-02  6.133e-02  -0.222   0.8246
## factor(district)10           -1.514e-02  6.868e-02  -0.220   0.8256
## factor(district)11           -3.743e-02  2.526e-02  -1.481   0.1385
## factor(district)12           -7.258e-03  4.448e-02  -0.163   0.8704
## factor(district)13           -1.967e-03  4.237e-02  -0.046   0.9630
## factor(district)14            1.745e-02  5.857e-02   0.298   0.7658
## factor(district)15           -4.782e-02  2.679e-02  -1.785   0.0742 .
## factor(district)16            1.700e-02  5.176e-02   0.328   0.7426
## factor(district)17           -4.967e-03  4.856e-02  -0.102   0.9185
## factor(district)18            7.847e-03  2.580e-02   0.304   0.7611
## factor(district)19            1.555e-02  3.617e-02   0.430   0.6673
## factor(district)20           -9.171e-03  3.316e-02  -0.277   0.7821
## factor(district)21           -5.344e-02  2.696e-02  -1.982   0.0474 *
## factor(district)22           -2.225e-02  1.984e-02  -1.122   0.2620
## factor(district)23            3.059e-03  4.001e-02   0.076   0.9391
## factor(district)24           -1.666e-02  3.086e-02  -0.540   0.5893
## factor(district)25            5.307e-04  7.431e-02   0.007   0.9943
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7068 on 1077743 degrees of freedom
##   (31 observations deleted due to missingness)
## Multiple R-squared:  0.0001217,  Adjusted R-squared:  -2.77e-05
## F-statistic: 0.8145 on 161 and 1077743 DF,  p-value: 0.9592
```

V - Panel Data: Individual Fixed Effects

```
### 5.1 Between estimation

between_data <- final_panel %>% as.data.table()
between_data <- between_data[,paste('avg', names(between_data)[4:22], sep="_") :=lapply(.SD,mean),
                             by=NUID,.SDcols=4:22] %>% as.data.frame()
# Renaming for presentation purposes
bet_data <- between_data %>%dplyr::select(1,2,3,23:41) %>%     rename(arrest=avg_arrest,tenure=avg_tenu
        p50_inc=avg_p50_inc,share_white = avg_share_white, share_hisp= avg_share_hisp, share_black =
bet_model <- lm(data=bet_data,arrest~tenure+tot_crim_per_res+p50_inc+
     share_white+share_hisp+share_black)



### 5.2 Within estimation

within_data <- left_join(final_panel %>%
                           dplyr::select(NUID,crime_month,arrest,tenure,tot_crim_per_res,
                                  p50_inc,tot_white,tot_hisp,tot_black),between_data)
```

```
## Joining, by = c("NUID", "crime_month", "arrest", "tenure", "tot_crim_per_res", "p50_inc", "tot_white
```

```
within_data <- within_data %>% mutate(
  w_arrest=arrest-avg_arrest,
  w_tenure=tenure-avg_tenure,
  w_tot_crim_per_res=tot_crim_per_res-avg_tot_crim_per_res,
  w_p50_inc=p50_inc-avg_p50_inc,
  w_share_white=share_white-avg_share_white,
  w_share_hisp=share_hisp-avg_share_hisp,
  w_share_black=share_black-avg_share_black
)
# Renaming for presentation purposes
within_data <- within_data %>%  dplyr::select(1,2,42:48) %>%  rename(arrest=w_arrest,tenure=w_tenure,to
        p50_inc=w_p50_inc,share_white = w_share_white, share_hisp= w_share_hisp, share_black =    w_sha

within_model <- lm(data=within_data,arrest~tenure+tot_crim_per_res+p50_inc+
     share_white+share_hisp+share_black)

### 5.3 First Difference
subset_panel<- final_panel %>% dplyr::select(NUID,crime_month,arrest,tenure,tot_crim_per_res,
                      p50_inc,share_white,share_hisp,share_black) %>%
              mutate(NUID=as.numeric(NUID))
ordered_panel <- subset_panel[order(subset_panel$NUID,subset_panel$crime_month),]
diff_panel <- NULL

# Looking for the first observation of each individual
min_month <- ordered_panel %>% group_by(NUID) %>% summarise(crime_month=min(crime_month))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
min_month <- min_month %>% mutate(drop=1)

# Computing differences
diff_panel <- ordered_panel[,3:9]-dplyr::lag(ordered_panel[,3:9])
diff_panel <- cbind(ordered_panel[,1:2],diff_panel)

# Removing the first observation of each individual
diff_panel <- left_join(diff_panel,min_month)
```

```
## Joining, by = c("NUID", "crime_month")
```

```
diff_panel <- diff_panel %>% filter(is.na(drop))
diff_panel <- diff_panel %>% dplyr::select(-drop)

# Estimate model
firstdiff_model <- lm(data=diff_panel, arrest~tenure+tot_crim_per_res+p50_inc+
                        share_white+share_hisp+share_black)
```

```
stargazer(bet_model,within_model,firstdiff_model,column.labels =c("Between","Within","First Difference"
```

% Table created by stargazer v.5.2.2 by Marek Hlavac, Harvard University. E-mail: hlavac at fas.harvard.edu
% Date and time: Mon, Apr 26, 2021 - 7:55:08 PM

We observe very different estimations of β depending on the model we choose. In first place, because they represent different things but also because of the nature of the data. The only turning out significant is

Table 1: Results

	Dependent variable:		
	Arrests		
	Between	Within	First Difference
	(1)	(2)	(3)
Tenure	-0.00001^{***}	0.00002	0.001
	(0.00000)	(0.00002)	(0.001)
Crimes per resident	-0.072^{***}	0.213	0.360
	(0.019)	(0.233)	(0.566)
Median Income	0.00000^{***}	−0.00000	−0.00000
	(0.000)	(0.00000)	(0.00000)
Share of White	-0.012^{***}	−0.028	−0.114
	(0.002)	(0.042)	(0.215)
Share of Hispanic	−0.0004	−0.045	−0.125
	(0.002)	(0.033)	(0.168)
Share of Black	-0.003^{**}	−0.043	−0.111
	(0.002)	(0.031)	(0.160)
Constant	0.502^{***}	−0.000	−0.001
	(0.002)	(0.001)	(0.001)
Observations	1,077,285	1,077,285	1,064,872
R^2	0.0002	0.00000	0.00000
Adjusted R^2	0.0002	−0.00000	−0.00000
Residual Std. Error	0.078 (df = 1077278)	0.702 (df = 1077278)	1.000 (df = 1064865)
F Statistic	42.255^{***} (df = 6; 1077278)	0.719 (df = 6; 1077278)	0.264 (df = 6; 1064865)
Note:			*p<0.1; **p<0.05; ***p<0.01

for the Between model. This indicates that the variation that allows for the estimation of our parameter is variation across individuals instead of variation over time. If we observe the data, variables related to the population (median income and shares by race) present only a limited series of discrete jumps, this is a large number of zeros and some large values. This is specially relevant for the first difference estimation were the only source of variation is due to irregularities in the data. Therefore, for the nature of the data observed, the between model is better than other specifications.

5.4 GMM estimation —-

The initial step would be to construct identification keys for individuals, months, and districts. For the latter, as its values are ordered integers, modification of the data is not necessary.

```
officers <- final_panel %>% dplyr::select(NUID) %>% unique()
officers <- officers %>% mutate(id_off=1:nrow(officers))

months <- final_panel %>% dplyr::select(crime_month) %>% unique()
months <- months %>% mutate(id_month=1:nrow(months))

gmm_panel <- left_join(final_panel,officers)
```

```
## Joining, by = "NUID"
```

```
gmm_panel <- left_join(gmm_panel,months)
```

```
## Joining, by = "crime_month"
```

```
GMM = function(param,gmm_panel){
  gmm_panel <- gmm_panel %>% drop_na()
  #Coefficients and preliminaries
  ni = max(gmm_panel$id_off)
  alpha = param[1:ni]
  beta = param[ni+1]
  gamma = param[(ni+2):(ni+6)]
  phi = param[(ni+7):(ni+31)]
  kappa = param[(ni+32):(ni+31+max(gmm_panel$id_month))]

  #Variables
  arrest = gmm_panel$arrest
  tenure = gmm_panel$tenure
  tot_crimes_pr = gmm_panel$tot_crim_per_res
  median_income = gmm_panel$p50_inc
  s_black= gmm_panel$share_black
  s_white= gmm_panel$share_white
  s_hisp= gmm_panel$share_hisp

  # Loop to compute estimates
  est=mat.or.vec(nrow(gmm_panel),1)
    for (ii in 1:nrow(gmm_panel)){
    est[ii] = alpha[gmm_panel$id_off[ii]]+beta*tenure[ii]+
```

```
      gamma[1]*tot_crimes_pr[ii] + gamma[2]*median_income[ii]+
      gamma[3]*s_black[ii]+gamma[4]*s_white[ii]+gamma[5]*s_hisp[ii]
    + phi[gmm_panel$district[ii]]+kappa[gmm_panel$id_month[ii]]
  }

  moments_est=all.moments(est,order.max=2)[-1]
  moments_arrest=all.moments(arrest,order.max=2)[-1]

  like = sum((moments_est - moments_arrest)^2)
  return(like)
}
```

The Generalized Method of Moments function

GMM Estimation Given that our sample consists of 13,029 officers along time and districts, this implies the estimation of 13,192 parametes if used the complete sample. To illustrate the results of the code, the estimation is done for the first 50,000 observations (~5% of the data).

```
set.seed(123456)
subset_gmm_panel <- gmm_panel[1:50000,]
param=runif(max(subset_gmm_panel$id_off)+6+max(subset_gmm_panel$id_month))/10000
GMM(param,subset_gmm_panel)
```

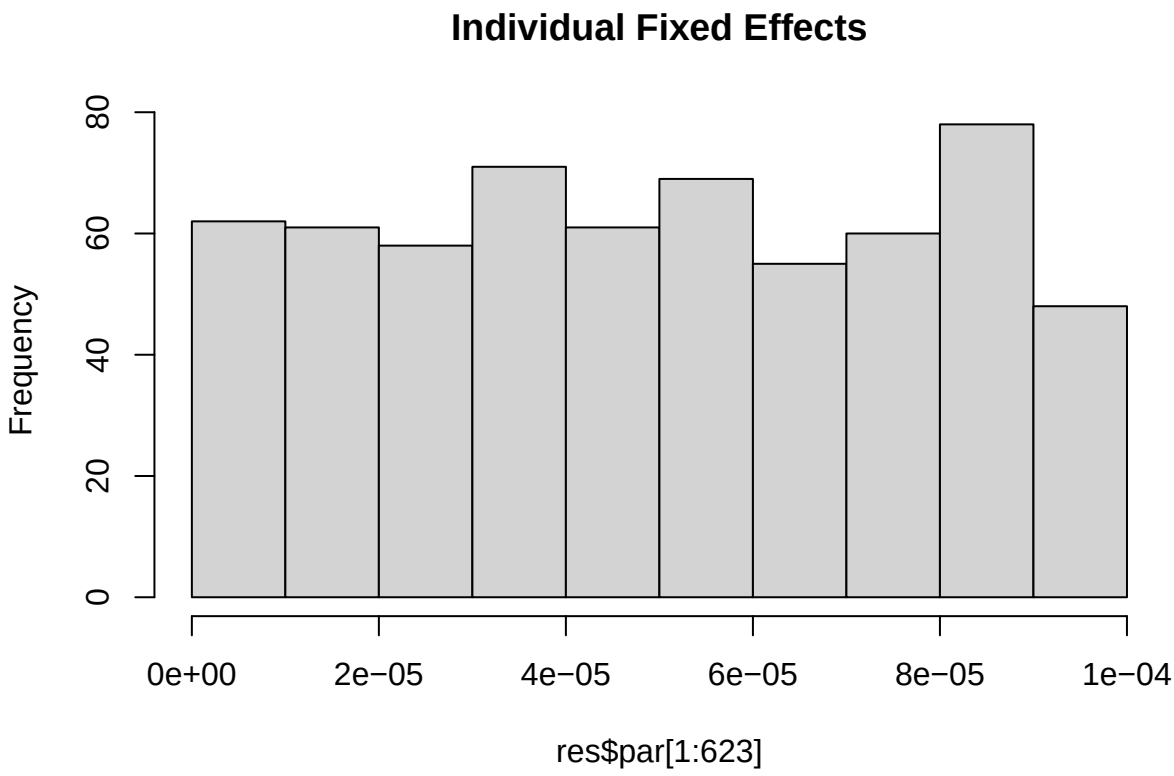
```
## [1] 0.7639939
```

```
res  = optim(param,fn=GMM,method="BFGS",control=list(trace=6,REPORT=1,maxit=1000),
             gmm_panel=subset_gmm_panel)
```

```
## initial  value 0.763994
## iter   1 value 0.763994
## final  value 0.763994
## converged
```

##Results of GMM Estimation

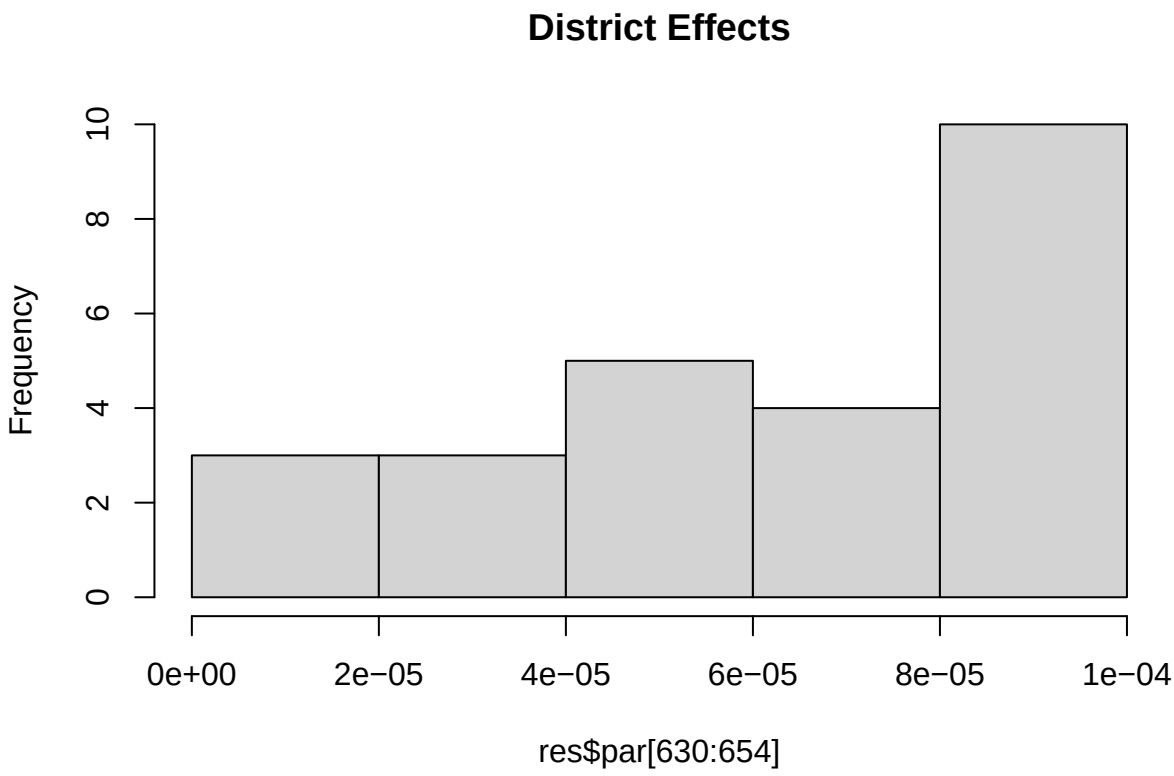
```
# Histogram of individual fixed effects
hist(res$par[1:623], main = "Individual Fixed Effects")
```



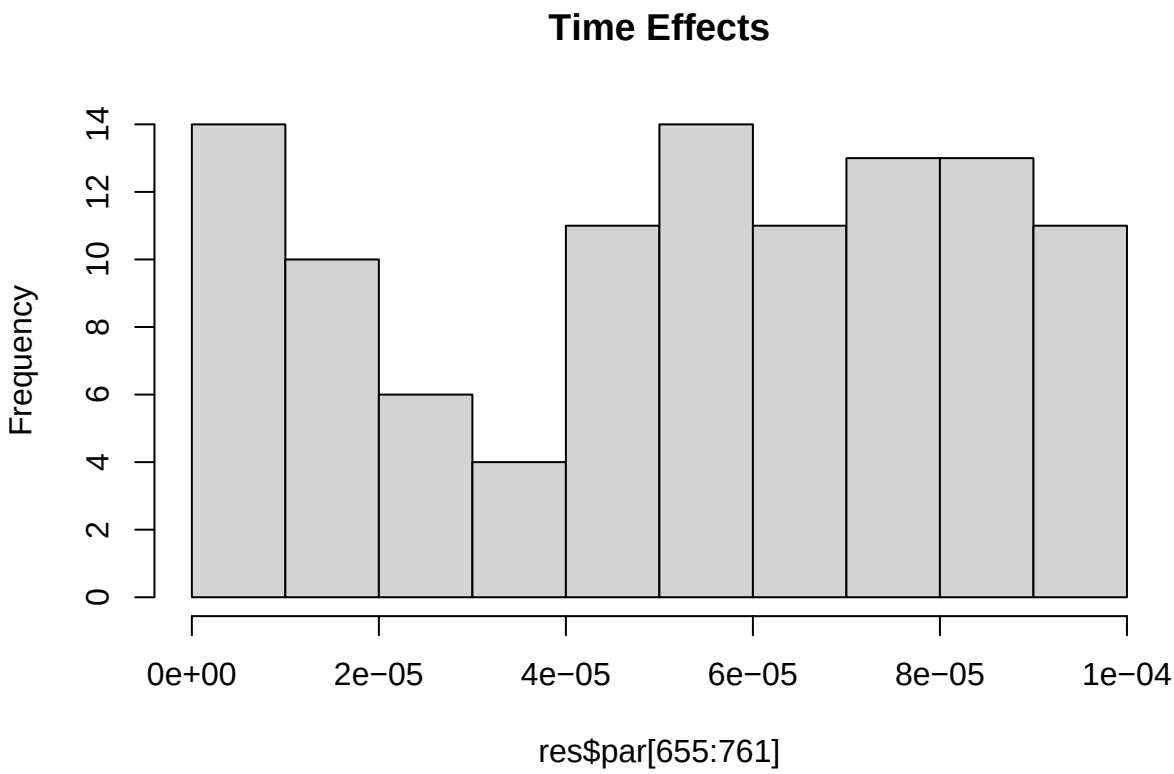

```
# Coefficients
gmm_coef <- res$par[624:629]
names(gmm_coef) <- c("Tenure","Crimes per resident","Median Income","Share of White","Share of Hispanic
gmm_coef
```

```
##              Tenure Crimes per resident       Median Income      Share of White
##       1.041439e-05        9.212897e-05        6.928717e-07        7.615308e-05
##   Share of Hispanic      Share of Black
##       9.982344e-07        1.021268e-05
```

```
# Histogram of district effects
hist(res$par[630:654], main = "District Effects")
```




```
# Histogram of time effects
hist(res$par[655:761], main = "Time Effects")
```


Time Effects
Frequency
0
2
4
6
8
10
12
14
0e+00
2e−05
4e−05
6e−05
8e−05
1e−04
res$par[655:761]